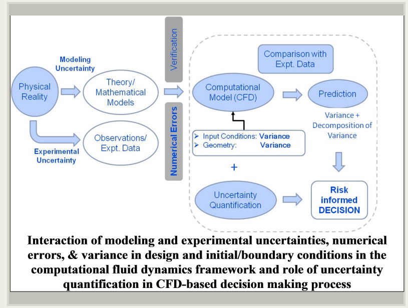
Non-Intrusive Computational Method and Uncertainty Quantification Tool for Isolator Operability Calculations, Phase I

Completed Technology Project (2017 - 2017)

Project Introduction

Computational fluid dynamics (CFD) simulations are extensively used by NASA for hypersonic aerothermodynamics calculations. The physical models used in CFD codes and initial/boundary conditions for numerical simulations carry significant uncertainties. There are also inherent errors in experiments designed for model validation, and numerical discretization. Despite this knowledge, only a limited number of efforts have been undertaken to formally characterize these uncertainties and to evaluate their impact on the predictive capability of CFD tools for hypersonic applications such as isolator dynamics. Major challenges with uncertainty quantification for such simulations include lack of sufficient data to characterize the associated uncertainties in the isolator dynamics phenomena and the computational cost of the required large number of cases. CFDRC in partnership with Virginia Tech and UTSI proposes to directly address these issues and deliver an non-intrusive tool for uncertainty quantification that can be integrated with the state-of-the-art CFD tools currently utilized by NASA and its customers. During Phase I, this team will develop and demonstrate a dimensionally adaptive sparse grid approach for uncertainty quantification coupled with NASA LaRC VULCAN-CFD code. In phase I, the developed tool will be demonstrated on the test rig developed and characterized at the NASA-LaRC Isolator Dynamics Research Lab. Surrogate models including polynomial response surface and gradient-enhanced Kriging will be developed based upon the samples generated from the adaptively sparse grid algorithm, thereby providing a modeling tool to estimate the operability of isolator over the relevant flight regime and ultimately to optimize design of isolator to prevent scramjet unstart. In Phase II, the framework will be further developed to include uncommon probability density distributions of uncertain parameters, and will be validated and demonstrated on more complex problems.



Non-Intrusive Computational Method and Uncertainty Quantification Tool for isolator operability calculations, Phase I Briefing Chart Image

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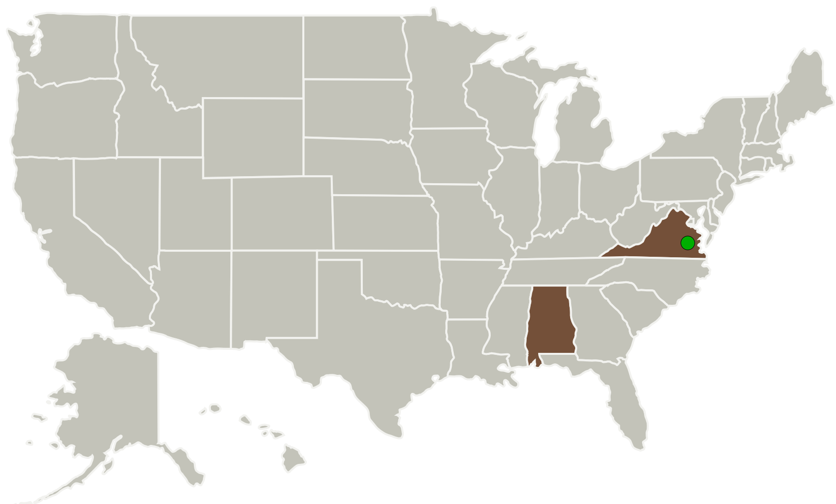
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Alabama	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

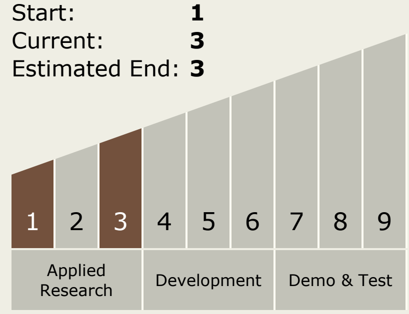
Carlos Torrez

Principal Investigator:

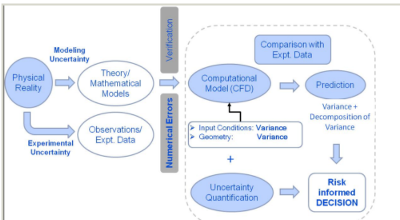
Ragini Acharya

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



Images



Interaction of modeling and experimental uncertainties, numerical errors, & variance in design and initial/boundary conditions in the computational fluid dynamics framework and role of uncertainty quantification in CFD-based decision making process

Briefing Chart Image

Non-Intrusive Computational Method and Uncertainty Quantification Tool for isolator operability calculations, Phase I Briefing Chart Image *(https://techport.nasa.gov/image/134800)*

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  └ TX15.1 Aerosciences
    └ TX15.1.5 Propulsion Flowpath and Interactions